Specification

PROCESSING APPARATUS

Technical Field

The present invention relates to a processing apparatus that takes out an object to be processed from a hermetic container and conducts a predetermined process to the object to be processed.

Background Art

As one of semiconductor manufacturing apparatuses, for example, there is a thermal processing apparatus that conducts a heat treatment to a plurality of semiconductor wafers (hereafter, to be simply referred to as "wafer") in a batch. This thermal processing apparatus is provided with a conveying in-and-out area where a carrier that is a container containing a plurality of wafers is conveyed in and out by an automatic conveying robot or by an operator, and a loading area where the wafers in the container are transferred and placed onto a wafer boat that is a substrate holder and are conveyed in and out from a heat treating furnace.

In this thermal processing apparatus, an atmosphere in the loading area is kept cleaner than an atmosphere in the conveying in-and-out area. In addition, in order to prevent that a natural oxide film is generated (adhered) on the wafers, the conveying in-and-out area on an atmospheric air side and the loading area are separated by a partition, and for example, an inside of the loading area is an atmosphere filled with an inert gas, such as a nitrogen (N_2) gas, or an atmosphere filled with a clean dry air.

Additionally, in order to restrain that the wafers are polluted by particles, a hermetic container (also referred to as a closed-type carrier), wherein a wafer taking-out port on a front side thereof is hermetically closed by a lid, is suitably used (refer to Fig. 1).

Fig. 10 is a cross-sectional view that shows a structure of a door mechanism in an example of conventional thermal processing apparatuses. Fig. 10 shows a condition wherein a hermetic carrier abuts on a partition 100 that defines a conveying in-and-out area S1

and a loading area S2.

In the partition 100, an opening part 101 for making the conveying in-and-out area S1 and the loading area S2 communicate with each other is formed. A door 102 for opening and closing the opening part 101 is provided with a lid opening-and-closing mechanism 103 for opening and closing a lid of a carrier.

The carrier 120 is capable of containing internally a plurality of wafers W that are objects to be processed. On one surface of a main carrier body 121 of the carrier 120, a taking-out port 122 is provided. The taking-out port 122 is closed by a lid 123 that is made detachable. Namely, the carrier 120 is a hermetic carrier. The carrier 120 is placed on a stage 110 provided in the conveying in-and-out area S1. Thereafter, when the stage 110 proceeds, an opening edge portion of the taking-out port 122 of the carrier 120 abuts on an opening edge portion of the opening part 101. Then, the lid 123 is removed from the main carrier body 121 by the lid opening-and-closing mechanism 103.

More concretely, in a condition wherein the door 102 abuts on the partition 100 and the opening part 101 is closed, the lid opening-and-closing mechanism 103 provided at the door 102 opens the lid 123 of the carrier 120. Then, the inside of the carrier 120 is replaced by a nitrogen gas by means of, for example, a not-shown nitrogen gas replacing unit. In the meantime, the lid opening-and-closing mechanism 103 holding the lid 123 is moved backward with respect to the partition 100 by means of a driving unit 104 in the door 102. As described above, the door 102 is withdrawn in a condition wherein the door 102 contains the lid 123 and the like. Here, the door 102 is withdrawn, for example, by being moved away from the opening part 101 along an anterior-posterior axis 105 and then by being moved, for example, downward along a vertical axis 106. Accordingly, the inside of the carrier 120 and a space in the loading area S2 are communicated with each other, and the wafers W in the carrier 120 are conveyed into the loading area S2 by means of a not-shown wafer transferring mechanism.

As described above, the wafers W that are objects to be processed are moved between the carrier 120 and the loading area S2. Here, it is necessary for the space for conveying the wafer W to be

maintained in an atmosphere of greatly clean.

So far, techniques to restrain an influence of particles accompanied by opening of a lid of a carrier or opening of a door have been variously suggested.

For example, in Japanese Patent Laid-Open Publication No. 2000-150613, a hermetic container (carrier) having a detachable lid at an opening part of a front surface thereof and containing an object to be processed (wafer) therein, and a wafer transferring-and-placing mechanism that conveys the wafer inside the hermetic container into a separated transferring-and-placing room (a loading area) and thereafter conveys the wafer into a processing room, are disclosed. In addition, the transferring-and-placing room on an opposite side to the opening part of the hermetic container is provided with a separated room to reduce pressure difference between the transferring-and-placing room and the hermetic container, and a lid opening-and-closing mechanism to open and close the lid of the hermetic container is provided in the separated room.

Additionally, in Japanese Patent Laid-Open Publication No. 2002-093880, an apparatus is disclosed, comprising a stage (a conveying in-and-out area) on which a cassette (a hermetic carrier) containing a plurality of semiconductor wafers (objects to be processed) is placed, a processing portion (a loading area) for conducting a predetermined process to the wafer, a partition which separates the stage from the processing portion and which is provided with an opening for transfer at a position corresponding to the opening of the cassette placed on the stage, a shutter member (a door) which is arranged on a side of the processing portion so as to open and close a lid, provided at the opening of the cassette placed on the stage and capable of being opened and closed, through the opening for transfer, and a shutter driving mechanism (a door opening-and-closing mechanism) which drives the shutter member, the shutter member including a holding portion (a lid opening-and-closing mechanism) to hold the lid, an opening for suction being formed at a circumference of the holding portion located at a position corresponding to a circumference of the opening of the cassette.

In either apparatus described above, when a space in an outside

space area in which the carrier containing the wafers is placed and a space in an inside space area in which a predetermined process is conducted to the wafers are communicated with each other, particles in the outside space area are restrained from entering into the inside of the carrier and adhering to the wafers and from flowing into the atmosphere in the inside space area, and accordingly pollution of the wafers is prevented.

However, even though the techniques as described above are used, it is actually still difficult to sufficiently reduce an influence degree of particles upon wafers, when a space in an outside space area, in which a carrier containing the wafers is placed, and a space in an inside space area, in which a predetermined process is conducted to the wafers, are communicated with each other.

Summary of the Invention

This invention has been made based on the above consideration, and an object of the invention is to provide a processing apparatus for processing an object to be processed contained in a hermitic container, wherein it is possible to reduce as far as possible an adverse effect of a particle in an outside space area against the object to be processed and against an inside space area and to surely prevent pollution of the object to be processed, when the outside space area in which the carrier is transferred and placed and the inside space area which is kept in clean atmosphere, for example, are communicated with each other.

The present invention is a processing apparatus for an object to be processed, comprising a partition that defines an outside space area in which a container hermetically containing an object to be processed and having a lid is conveyed and an inside space area in which the object to be processed taken out from the container is conveyed, an opening part provided in the partition through which the two space areas are communicated with each other, a door mechanism that can close the opening part, a lid opening-and-closing mechanism provided at the door mechanism capable of opening and closing the lid of the container located at a predetermined position in the outside space area under a situation wherein the door mechanism closes the opening part, a driving unit that moves the lid opening-and-closing mechanism away from the

container relatively to the door mechanism, a cover member that defines a driving-unit arrangement room in which the driving unit is contained in the door mechanism, and a gas-discharging mechanism that discharges a gas in the driving-unit arrangement room.

According to the present invention, the driving unit that moves the lid opening-and-closing mechanism away from the container is located inside a driving-unit arrangement room formed separately from a door-mechanism space which is formed between the door mechanism itself and the container by the door mechanism, and the gas-discharging mechanism is provided to discharge the gas in the drive-unit arrangement room, so that a dust is removed by the gas-discharging mechanism even when the dust is generated by movement of the driving unit for opening and closing the lid of the container. Therefore, it is surely prevented that the dust enters into the door-mechanism space and adheres on the object to be processed in the container, and also prevented that the clean atmosphere and so on in the inside space area is polluted when the door mechanism is opened. As a result, a degree of the adverse effect by the dust (particle) against the object to be processed is restrained to be small and the object to be processed to which a predetermined process has been conducted can keep a high clean level.

Preferably, an end edge of the opening part on a side of the inside space area forms a plane inclined against the partition, and the door mechanism is hermetically connectable with the end edge and movable in a plane direction of the partition.

In this case, possibility that a dust is generated by a withdrawing movement of the door mechanism is reduced. Therefore, it is more surely prevented that the object to be processed or the clean atmosphere in the inside space area are polluted by the dust.

In addition, preferably, a sealing member is provided at the whole circumference of an end edge of the opening part on a side of the outside space area, and the lid opening-and-closing mechanism is hermetically connectable with the sealing member by an action of the driving unit under a situation wherein the door mechanism closes the opening part.

In this case, it is possible to prevent that the door-mechanism

space is exposed to the atmosphere in the outside space area even when the container is not located at a predetermined position (on the stage, for example). Therefore, it is surely prevented that a dust floating in the outside space area, for example, enters into the door-mechanism space.

For example, the sealing member is a member having a Y-shaped section.

Incidentally, if the space inside the carrier and the space of the inside space area are communicated with each other at once, a dust existing in the door-mechanism space rises up due to a pressure difference between a pressure inside the carrier and a pressure in the inside space area, and then adheres on the object to be processed in the container and mixes into the inside of inside space area. Therefore, it is preferable that the door mechanism has a pressure-adjusting mechanism that can gradually open through one space and the other space with respect to the door mechanism in order to leisurely reduce a difference pressure between the both spaces to substantially zero.

Brief Description of the Drawings

Fig. 1 is a perspective view showing a hermetic container in such a condition that a lid is removed;

Fig. 2 is a perspective view showing a vertical thermal processing apparatus according to one embodiment of the present invention;

Fig. 3 is a longitudinal sectional view showing an inside structure of the vertical thermal processing apparatus shown in Fig. 2;

Fig. 4 is a plan view showing the inside structure of the vertical thermal processing apparatus shown in Fig. 2;

Fig. 5 is a longitudinal sectional view showing one example of a door mechanism which opens and closes an opening part formed in a partition, in such a condition that a carrier containing a wafer abuts on the partition;

Fig. 6 is a back view of the door mechanism shown in Fig. 5;

Fig. 7 is a partial cross-sectional view showing a condition wherein a bottom of the carrier and an engaging member of a second stage are engaged;

Fig. 8 is a cross-sectional view, similar to Fig. 5, showing a

condition wherein the door mechanism is withdrawn upward and a space inside a conveying in-and-out area and a space inside a loading area are communicated with each other;

Fig. 9 is a cross-sectional view, similar to Fig. 5, showing a condition wherein the opening part in the partition is closed by the door mechanism when the carrier is not on the second stage; and

Fig. 10 is a cross-sectional view showing a structure of a door mechanism in one example of a conventional thermal processing apparatus in such a condition that a hermetic carrier abuts on a partition which defines a conveying in-and-out area and a loading area.

Best Mode for Carrying Out the Present Invention

In a processing apparatus of the present invention, a hermetic container containing an object to be processed is placed at a predetermined position, and then the object to be processed is taken out from the container, and conveyed into an inside space area, which is maintained under a clean atmosphere, to be subjected to a predetermined process.

A carrier 10 including a main carrier body 11 is used, for example, as a container containing the object to be processed, as shown in Fig. 1. A taking-out port 11A is opened at one surface of the main carrier body 11. The taking-out port 11A is closed by a lid 12 that is provided to be removable. The carrier 10 is, for example, made of resin. The object to be processed is, for example, a wafer W whose diameter is 300 mm. The carrier 10 is composed so as to be capable of holding a plurality of, for example, 25 wafers W in a tier-like manner.

The lid 12 of the carrier 10 includes a not-shown latch mechanism (a lock mechanism) for the lid 12 to be held at the taking-out port 11A. When the latch mechanism is unlatched (released) by a lid opening-and-closing mechanism which is described later, the lid 12 can be removed from the main carrier body 11.

In Fig. 1, 13 represent a keyhole used for unlatching the latch mechanism. An unlock member of the lid opening-and-closing mechanism is inserted into the keyhole 13 and engaged with it. 14 represents a square-shaped flange portion provided above a top surface of the carrier 10 via a space. 15 represents a recess portion, whose

cross section is round-shaped, formed at a center part of the flange portion 14.

Next, a vertical thermal processing apparatus in one embodiment of the present invention is explained in details.

Fig. 2 is a perspective view showing an appearance of the vertical thermal processing apparatus according to this embodiment. Figs. 3 and 4 are respectively a longitudinal sectional view and a plan view showing an inside structure of the vertical thermal processing apparatus shown in Fig. 2. Fig. 5 is a longitudinal sectional view showing an outline of a structure of one example of a door mechanism which opens and closes an opening part formed in a partition, under a condition wherein the carrier containing the wafers abuts to the partition. Fig. 6 is a back view of the door mechanism shown in Fig. 5.

In Figs. 2 to 4, 20 represents a housing which composes an outer cover of the processing apparatus. In this housing 20, a conveying in-and-out area S1 that is an outside space area, in which the above-described hermetic carrier 10 containing the wafers W that are objects to be processed is conveyed, and a loading area S2 that is an inside space area, in which the wafers W being taken out from the carrier 10 are conveyed, are defined (divided) by a partition 21.

The atmosphere of the conveying in-and-out area S1 is, for example, an air atmosphere, to be concrete, an environmental atmosphere of a clean room in which the thermal processing apparatus is installed. On the other hand, the atmosphere of the loading area S2 is maintained to be an inert gas atmosphere cleaner than the atmosphere of the conveying in-and-out area S1, such as a nitrogen (N_2) gas atmosphere or a clean dry gas (an air which includes less particles and less organic constituents and whose dew point is maintained not higher than -60 °C) atmosphere.

The conveying in-and-out area S1 includes a first conveying area S1A located on a front side of the thermal processing apparatus and a second conveying area S1B located on a back side thereof.

In the first conveying area S1A, two first stages 22, 23 are arranged side by side in the right-and-left direction (in the vertical direction in Fig. 4). Accordingly, when the carrier 10 is placed on any one of the first stages 22, 23, it can be conveyed by a carrier conveying

mechanism 31 which is described later.

On a placing surface of each of the first stages 22, 23, positioning pins 24 for fitting with a recess portion formed at a bottom portion of the carrier 10 to locate the carrier 10 on the first stages 22, 23 are provided, for example, at three spots (refer to Fig. 2).

Additionally, on a front side of the housing 20, a panel part 25, whose cross section shape seen from above is C-shaped, is provided in such a manner that it surrounds an upper space of the first stages 22, 23. An area surrounded by the panel part 25 is an area wherein the carrier 10 is transferred between a not-shown automatic conveying robot movable along a ceiling portion in a clean room and the first stages 22, 23.

In the second conveying area S1B in the conveying in-and-out area S1, two second stages 26, 27 respectively corresponding to the first stages 22, 23 are arranged side by side in an anterior-posterior direction with respect to the first stages 22, 23.

The second stages 26, 27 are composed so that they are capable of proceeding and withdrawing in the anterior-posterior direction (in the right-and-left direction in Fig. 4) between a position wherein the carrier 10 is placed thereon by means of a carrier conveying mechanism 31 to be described later and a position wherein the carrier 10 abuts to the partition 21, by means of, for example, a driver composed of an air cylinder (not shown).

Similar to the first stages 22, 23, positioning pins 28 for positioning the carrier 10 are provided at three spots on each placing surface of the second stages 26, 27. Additionally, on each placing surface of the second stages 26, 27, as shown in Fig. 7, a hook-shaped engaging member 29 to be engaged with an engaging recess portion 16 at a bottom portion of the carrier 10 is provided. The engaging member 29 is composed pivotable around a horizontal axis by a driver 29A between a position to engage with the engaging recess portion 16 of the carrier 10 and a position wherein the engagement is disengaged.

In an upper part of the second conveying area S1B, a carrier storing part 30 for storing the carrier 10 temporarily is provided. The carrier storing part 30 in this example is composed of a shelf having two steps and two rows.

Furthermore, in the second conveying area S1B, a carrier conveying mechanism 31 which conveys the carrier 10 between the first stages 22, 23 and the second stages 26, 27 as well as between the second stages 26, 27 and the carrier storing part 30, and between the first stages 22, 23 and the carrier storing part 30, is provided.

The carrier conveying mechanism 31 comprises: a guide part 32 extending right and left and freely movable upward and downward; a moving part 33 that moves right and left while guided by the guide part 32; and a joint arm 34 provided at the moving part 33 to hold the flange portion 14 on the top surface of the carrier 10 and to convey the carrier 10 in the horizontal direction.

The loading area S2 is provided with a vertical heat treating furnace 40 whose lower end is opened as a furnace opening. On a lower side of the heat treating furnace 40, a wafer boat 41, which is a holder for holding a plurality of wafers W in a tier-like manner, is placed on a cap 43 via an insulation member 42. The cap 43 is supported on an elevating mechanism 44. By means of the elevating mechanism 44, the wafer boat 41 is conveyed in or out of the heat treating furnace 40.

The loading area S2 is provided with a wafer transferring mechanism 45, which transfers the wafers W between the wafer boat 41 and the carrier 10 on the second stages 26, 27. The wafer transferring mechanism 45 is composed as a plurality of, for example 5, arms 48 capable of proceeding and of withdrawing and provided at a moving part 47 that moves along a guide mechanism 46 extending right and left and that can pivot around a vertical axis.

In the partition 21 defining the conveying in-and-out area S1 and the loading area S2, an opening part 21A is formed at a position corresponding to each of the second stages 26, 27. The opening part 21A can cause the inside of the carrier 10 and the space of the loading area S2 to communicate with each other when the carrier 10 placed on the second stages 26, 27 abuts to the partition 21. An end edge of the opening part 21A on a side of the conveying in-and-out area S1 is provided with a sealing member 50 for hermetically connecting with the carrier 10, in details, with an opening end edge of the taking-out port 11A of the carrier 10, at the whole circumference of the end edge of the opening part 21A.

This sealing member 50 is, for example, composed of a packing whose cross section is Y-shaped.

Additionally, on a side of the conveying in-and-out area S1 of the partition 21, pressing means 55, 56 for pressing an upper surface of the carrier 10 placed on the second stages 26, 27 from above to stabilize the pose of the carrier 10 when the lid 12 is opened and closed, are provided at respective positions corresponding to the second stages 26, 27.

In this embodiment, an opening plane of the opening part 21A is formed in an inclined condition with respect to a conveying direction of the wafer. Concretely, as shown in Fig. 5, an inclined opening plane is formed by allowing a frame member 60, whose cross section is a substantial wedge-shaped, to be fitted tightly in the opening part formed in the partition 21.

Furthermore, a side edge portion of the opening part 21A of the partition 21 is provided with a nitrogen gas supplier (not shown). Accordingly, an inert gas, for example, a nitrogen gas is supplied under a condition wherein the lid 12 of the carrier 10 has been removed, and the atmosphere of the carrier 10 is replaced by a nitrogen gas atmosphere.

On a side of the loading area S2 of the partition 21, provided is a door mechanism 70 which opens and closes the opening part 21A. The door mechanism 70 is held by holding members 66, 66 which are provided to be capable of moving respectively on two guide shafts 65, 65 extending upward and downward along the partition 21 in such a manner that they are arranged side by side from each other (in the right and left direction in Fig. 6).

The door mechanism 70 includes a door 71, which forms an atmosphere adjusting space separated from the loading area S2 by abutting to the opening plane of the opening part 21A. The door 71 hermetically closes the opening part 21A via a sealing member 79 provided at the frame member 60.

A lid opening-and-closing mechanism 75 which opens and closes the lid 12 of the carrier 10 is provided inside the door 71. In addition, a driving unit 76 which moves the lid opening-and-closing mechanism 75 in a direction for connecting or disconnecting to the carrier 10 (in the right and left direction in Fig. 5) is arranged in a driving-unit

arrangement room 81 formed and defined by the cover member 80 at a lower end portion of the door 71. On an upper defining wall of the driving-unit arrangement room 81, a guiding groove 81A to guide a supporting member for supporting the lid opening-and-closing mechanism 75 is formed.

The lid opening-and-closing mechanism 75 includes an unlock member 77 which can tightly fit in the keyhole 13 of the lid 12 of the carrier 10 and is exposed to an outside surface of the outer box, and a driving unit 78 composed of, for example, an air cylinder provided inside the outer box. Under a condition wherein the unlock member 77 is inserted into the keyhole 13 of the lid 12 and is tightly fitted therein, when the unlock member 77 is rotated by an bending and/or stretching movement of the driving unit 78, lock of the lid 12 of the carrier 11 is adapted to be unlocked.

The lid opening-and-closing mechanism 75 is moved forward to the conveying in-and-out area S1 by the driving unit 76 and abuts to the lid 12 of the carrier 10 under a condition wherein the door 71 is closed and the conveying in-and-out area S1 and the loading area S2 are closed. At this time, the lid opening-and-closing mechanism 75 is also hermetically connected to the sealing member 50 which is provided on the partition 21. Accordingly, a high-level air-tightness is secured between the conveying in-and-out area S1 and the loading area S2. And then, the lid opening-and-closing mechanism 75 is moved apart from the opening part 21A after holding the lid 12 of the carrier 10 in order to convey the wafers W in the carrier 10 to the loading area S2. Accordingly, the lid 12 is contained inside the door 71.

The door mechanism 70 is provided with a gas-discharging mechanism for discharging a gas from an inside of the driving-unit arrangement room 81 and from an inside of the outer box of the lid opening-and-closing mechanism 75.

In the concrete, the gas-discharging mechanism comprises: a suction port 86 A opening to the inside space of the driving-unit arrangement room 81; a suction port 86B opening to the inside space of the lid opening-and-closing mechanism 75; a common gas-discharging port 87 provided at an outside of the door mechanism 70 and connected to each of the suction ports 86A, 86B; and a suction means (not shown),

such as a pump and so on, provided at an outside of the processing apparatus.

Furthermore, when the door mechanism 70 opens the opening part 21A of the partition 21, the door mechanism 70 has a function for adjusting pressure so as to leisurely reduce a pressure difference between a pressure inside the carrier 10 and a pressure of the loading area S2 to substantially zero.

In the concrete, an opening 90 formed at a back wall of the door 71 is provided with a damper mechanism 92 through a filter 91. The pressure inside the door 71 is adjusted by controlling a movement of the damper mechanism 92 to gradually open the opening 90. For example, when the pressure in the carrier 10 is 19.6×10^4 - 29.4×10^4 Pa (20 - 30 mAq) and the pressure in the loading area S2 is 49×10^4 - 98×10^4 Pa (50 - 100 mAq) under a condition wherein the lid 12 has been removed and a nitrogen gas has been purged, the pressure in the carrier 10 is adjusted so as to become the same as the pressure in the loading area S2 by taking a time for 1 - 10 seconds.

Hereinafter, an operation of the vertical thermal processing apparatus as described above is explained.

Firstly, the carrier 10 is moved down through the inside space of the panel part 25 by the not-shown automatic conveying robot which moves along the ceiling portion of the clean room, and is placed on the first stage 22 (23). And then, the carrier 10 is conveyed onto the second stage 26 (27) by means of the carrier conveying mechanism 31.

Next, the second stage 26 (27) is moved to a side of the partition 21. Accordingly, the end edge of the opening of the taking-out port 11A of the carrier 10 hermetically abuts to the end edge of the opening of the partition 21 via the sealing member 50. Under this situation, the pressing means 55 (56) is driven by an appropriate driving unit and is made to lie on its side. At this time, a protruding portion (not shown) of the pressing means 55 (56) is tightly fitted in the recess portion 15 of the flange portion 14 of the carrier 10, and the carrier 2 is fixed in such a condition that the carrier 2 is pressed from above by the pressing means 55 (56).

Thereafter, the gas-discharging mechanism in the door mechanism 70 is activated, and the atmosphere in the lid

opening-and-closing mechanism 75 and in the driving-unit arrangement room 81 is discharged at a flow rate of, for example, 0.01 - 0.1 m^3/min. Under this situation, the lock of the lid 12 of the carrier 10 is unlocked by the lid opening-and-closing mechanism 75, and the lid opening-and-closing mechanism 75 is withdrawn with holding the lid 12. Accordingly, the inside space of the carrier 10 is opened. Under this situation, an inert gas such as a nitrogen gas is supplied horizontally into the carrier from a gas-supplying pipe at a flow rate of, for example, 0.05 - 0.5 m^3/min. Accordingly, the atmosphere in the carrier 10 and the door 71 is replaced by the inert gas. At this time, since the inert gas is introduced in a relatively large amount, there is a possibility that the pressure in the carrier 10 rises up and also the air-tightness between the end edge of the opening part of the carrier 10 and the sealing member 50 is damaged due to a shock when the gas is introduced. However, since the carrier 10 is pressed from above by the pressing means 55 (56), the carrier 10 is not dislocated actually and the air-tightness is not damaged.

After that, the damper mechanism 92 is activated and the pressure in the carrier 10 is adjusted so as to leisurely become the same pressure as in the loading area S2 after some time. Then, as shown in Fig. 8, the door mechanism 70 is moved upward along the partition 21 and withdrawn from the opening part 21A in such a condition that it contains the lid opening-and-closing mechanism 75 holding the lid 12 in the door 71, in order not to interrupt the transferring movement of the wafers W by the wafer transferring mechanism 45. Accordingly, the inside of the carrier 10 and the space of the loading area S2 are communicated with each other.

After that, the wafers W in the carrier 10 are taken out one after another and placed on the wafer boat 41 by the wafer transferring mechanism 45. When the transferring of the wafers is finished, a reverse movement to one described above is conducted. Namely, the opening part 21A is hermetically closed by the door mechanism 70, the lid 12 of the carrier 10 is closed by the lid opening-and-closing mechanism 75, the fixation by the pressing means 55 (56) is removed, the second stage 26 (27) is withdrawn and the carrier 10 is moved away from the partition 21, and the carrier 10 is transferred into the carrier

storing part 30 by the carrier conveying mechanism 31 to be kept therein temporally.

On the other hand, when a predetermined number of wafers W are mounted on the wafer boat 41, the wafer boat 41 is conveyed into the heat treating furnace 40. The heat treating furnace 40 conducts a predetermined heat treatment, for example, a CVD treatment, an annealing treatment, an oxidation treatment and so on, to the wafers W. Thereafter, the conveying movement of the carrier 10 from the carrier storing part 30 to the second stage 26 (27) by the carrier conveying mechanism 31, the opening movement of the lid by the lid opening-and-closing mechanism 75, the withdrawing movement of the door mechanism 70, and the transferring movement of the wafers by the wafer transferring mechanism 45, are conducted in order, so that the wafers W are returned to the carrier 10. After that, the lid 12 is closed by the lid opening-and-closing mechanism 75 and the carrier 10 is conveyed to an outside of the apparatus.

In this way, according to the processing apparatus having the structure described above, since the driving unit 76 of the lid opening-and-closing mechanism 75 is arranged in the driving-unit arrangement room 81 separated from the door mechanism space (the space inside the door 71) which is formed between the door mechanism 70 and the carrier 10 as well as it is provided with the gas-discharging mechanism for discharging the gas inside the driving-unit arrangement room 81, even when a dust is raised accompanied by a sliding movement in the anterior-posterior direction of the driving unit 76 when the lid 12 of the carrier 10 is opened or closed, the dust is discharged to outside through the suction port 86A and removed. In addition, a dust which is raised accompanied by the opening-and-closing movement of the lid by the lid opening-and-closing mechanism 75 is also discharged to outside through the suction port 86B and removed. Therefore, it is possible to surely prevent a dust from entering into the space inside the door mechanism and adhering to the wafers W in the carrier 10, and also it is possible to surely prevent the clean atmosphere in the loading area S2 from being polluted when the door mechanism 70 is opened. As a result, an adverse effect on the wafers W by a dust (particles) can be lessened to a small degree.

Additionally, in this processing apparatus, the air of the space inside the door mechanism is also discharged via the suction port 86A through the guiding groove 81A provided at the upper defining wall forming the driving-unit arrangement room 81. Therefore, an adverse effect on the wafers W by a dust (particles) can be lessened to as small a degree as possible.

In addition, since the door mechanism 70 is composed so as to be moved in parallel to any direction in the plane of the partition 21, an upward direction in the example shown in the figure, along the partition 21 and to be withdrawn from the opening part 21A, the number of moving portions(sliding spots) relating to the lid opening-and-closing movement is lessened so as to reduce the possibility that a dust is raised accompanied by the withdrawing movement of the door mechanism 70, compared with the conventional door mechanism explained with reference to Fig. 10, for example. Accordingly, it is possible to further surely prevent the wafers W or the atmosphere in the loading area S2 from being polluted by a dust.

Furthermore, since it is such a composition that the sealing member 50 is provided at the end edge on the side of the conveying in-and-out area S1 of the opening part 21A, and the lid opening-and-closing mechanism 75 provided at the door mechanism 70 is connected closely to the sealing member 50 and sealed hermetically in a condition wherein the opening portion 21A is closed, as is shown in Fig. 9, the space inside the door mechanism is not exposed to the atmosphere of the conveying in-and-out area S1 even when the carrier 10 is not placed on the second stage 26 (27). Accordingly, it is possible to surely prevent a dust, which is for example floating in the conveying in-and-out area S1, from entering into the space inside the door mechanism.

Additionally, when the carrier 10 and the space in the loading area S2 are communicated with each other all at once, the dust existing in the space inside the door mechanism is stirred up because of the pressure difference between the pressure in the carrier 10 and the pressure in the loading area S2, and is allowed to adhere to the wafers W in the carrier 10 and to get mixed into the loading area S2. However, since the door mechanism 70 is provided with the damper mechanism

92 that leisurely adjusts the pressure in order to reduce the pressure difference between the pressure in the loading area S2 and the pressure in the carrier 10 to substantially zero, it is possible to surely prevent the troubles described above, and to surely prevent the wafers from being polluted.

When a heat treatment was conducted to wafers having a diameter of 300mm in the thermal processing apparatus provided with the door mechanism shown in Fig. 10, the increase of number of particles not less than 0.16 μm per one RUN was 10. In comparison with this, when a heat treatment was conducted to wafers having a diameter of 300mm in the thermal processing apparatus of the present invention, the increase of number of particles not less than 0.1 μm per one RUN was 2. That is, it was confirmed that it is possible to surely restrain pollution of the wafers by the particles according to the present invention.

Although the embodiment of this present invention has been explained as above, the present invention is not limited to the embodiment described above and it is possible to add various changes.

For example, the present invention can be applied not only to the vertical thermal processing apparatus but also to any apparatus to conduct a predetermined process to an object to be processed, such as a thermal processing apparatus of sheet-fed type, an apparatus for applying a resist or developing, an ion implantation apparatus and so on.

In addition, the atmosphere in the loading area is not limited to an inert gas but it may be a clean dry air. In this case, after the carrier abuts to the partition, the clean dry air may be supplied into the carrier so that the atmosphere in the carrier may be replaced by the clean dry air.

Additionally, the present invention is applicable for an apparatus in which an area for conveying a carrier and an area for conveying the carrier to an outside are provided at separated places.

Furthermore, in the above embodiment, a suction duct can be provided in the loading area so as to surround the circumference of the door mechanism in such a manner that the withdrawing direction of the door mechanism is opened. In this case, even when a dust is raised accompanied by the withdrawing movement of the door mechanism, the

dust is removed by the suction duct. Therefore, an adverse effect on the wafers and the clean atmosphere in the loading area by particles can be lessened to as small a degree as possible, and it is possible to surely restrain the pollution of the wafers. Moreover, it is possible to contain a cable air tube and so on, which is connected to the gas-discharging port, in the suction duct. In this case, even when a dust and so on are raised due to the movement of the cable air tube accompanied by the withdrawing movement of the door mechanism, an adverse effect on the wafers is surely prevented.